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Author: Mr. Thomas Gemmer
North Carolina State University, United States, trgemmer@ncsu.edu

Prof. Andre Mazzoleni
North Carolina State University, United States, apmazzol@ncsu.edu

SOLAR WIND ION FOCUSING THRUSTER (SWIFT) PERFORMANCE ANALYSIS

Abstract

Several studies were conducted in the 1960's and 70's concerning the applications of interplanetary ramjets. These studies proposed using some type of magnetic or electrostatic technique to collect ions from the solar wind and feed them into a pulsed fusion reactor to generate thrust. At the 65th International Astronautical Congress (IAC) we introduced a variant of this type of propulsion system that avoids some drawbacks of previous designs. Consider a series of wires arranged as a cone with the large open end facing the sun. If the wires are highly positively charged and not farther apart than the solar wind plasma Debye length, then the protons in the solar wind will be repelled by the wires and cannot escape the cone. If nothing else was done, then the whole structure would be pushed along like a variant of an electric sail; however, if the focused, higher density plasma in the base of the cone is connected to an ion acceleration stage, then the protons can be accelerated out the small end of the cone at much higher velocities than they had when they entered the cone. This proton beam could then be directed in any desired direction to propel the spacecraft. We call this concept a Solar Wind Ion Focusing Thruster or “SWIFT”.

In our paper for the 65th IAC, we presented an overview of the SWIFT powered craft, including the forces generated by accelerating the solar wind particles, the power required to operate the system, and the total system mass. In this paper, we extend this work by using the models we have developed to study several mission scenarios which can be accomplished using SWIFT technology. The mission performance of the SWIFT is examined for various representative mission types:

- Rendezvous with an object (e.g. a planet or asteroid)
- Fast mission to the outer solar system or Kuiper Belt
- Solar system escape missions

This is a parametric study over the key variables which will have the largest impact on system performance (e.g. exhaust velocity, total system mass, and size). This allows us to determine the operating parameters which will need to be achieved in order for a SWIFT system to be implemented for actual missions. We also compare the results for the SWIFT to similar systems (i.e. solar and electric sails and ion propulsion) to demonstrate the performance advantages of the SWIFT.